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SPECIAL REPORT P3

STUDIES OF THE BIOLOGY AND CONTROL OF THE SPRUCE BUDWORM IN OREGON AND WASHINGTON

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SUBJECT—

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STUDIES OF THE BIOLOGY AND CONTROL OF THE SPRUCE BUDWORM IN OREGON AND WASHINGTON, SEASON OF 1952

SUMMARY

Studies of the biology of the spruce budworm were continued in 1952 with major emphasis on: (1) The natural control factors affecting the budworm on unsprayed areas, and (2) the trends of budworm populations and parasitism on sprayed areas.

Studies on three unsprayed areas in eastern Oregon gave no indication that significant changes in the natural control of the budworm by parasitism can be expected in 1953. Aggregate parasitism for the three areas averaged 39 percent as compared with an average of 33 percent in 1951. Two of the areas showed static or declining budworm populations, in spite of the relatively light aggregate parasitism in 1951, indicating that some factor or factors other than parasitism has exerted considerable natural control.

Investigations on eight sprayed areas in Oregon and Washington showed that in general the budworm infestation remained at a low population level. Treatment on these areas dates back to 1949 and 1950. Parasitism on the sprayed areas was computed for immature larvae only. It was found that the parasites of early instar larvae are continuing to play a significant part in the natural control of these low budworm populations. The average total parasitism for the budworm collected on all sprayed areas was 32 percent which is greater than total parasitism of the immature larval stage on the unsprayed areas.

REVIEW OF PREVIOUS WORK

Biological studies of the spruce budworm in Oregon and Washington have been carried on annually since 1948. Studies during that first year were mainly on the seasonal history and habits of the budworm, and on budworm parasitism. The results of the 1948 studies were summarized by Speers in the report of Eaton et al. (6). 1/ In 1949 the studies were widely dispersed with parasite investigations in eastern Oregon and general biological studies in western Oregon. The parasite studies were reported by Buchanan (2) and the general studies reported by Lindsten and Wright (8). As a result of these preliminary investigations, basic biological information has been obtained which is necessary in planning and operating control programs, and in conducting and analyzing the results of population surveys.

The biological investigations currently underway were initiated in 1950 by the New Haven Forest Insect Laboratory in cooperation with the Portland Laboratory. The principal objective of the 1950 investigations was to determine the biology and natural control of the budworm on unsprayed areas. The results of these studies gave no indication that natural control was causing a significant reduction in the overall budworm epidemic. This observation was verified in 1951 when the general epidemic continued largely unchanged on the unsprayed areas. The 1950 studies were summarized by Carolin (3).

In 1951 the cooperative studies of natural control on unsprayed areas were continued and the program of study expanded to include studies on sprayed areas. The principal objectives in 1951 were to determine: (1) The biology and natural control of the budworm on unsprayed areas, and (2) the status of the budworm and its natural enemies on sprayed areas. The results of the 1951 studies on unsprayed areas again gave no indication that natural control was causing significant reductions in the overall epidemic. Studies on sprayed areas showed that in general the residual budworm population on areas treated early in the spray program, in 1949 and 1950, was very low. These latter studies also revealed that the parasites of the immature larvae obviously survived the spraying very well and were exerting considerable pressure on the residual budworm population, while parasites of the mature larvae appeared to have been reduced to a relatively low level by spraying. The observations regarding natural control on unsprayed areas was later verified when the general epidemic continued at about the same level. The results of the 1951 studies were summarized by Carolin and Wright (4).

1/ Underlined numbers in parenthesis refer to Literature Cited page 8.

STUDIES IN 1952 ON UNSPRAYED AREAS

The studies on unsprayed areas in 1952 were designed primarily to investigate the natural control effected by parasites. The three areas under intensive study in 1951 at Chesnimnus, North Powder, and Waterman Flat were reexamined. Unfortunately only partial data was obtained from Waterman Flat as that area was sprayed at mid-season. All three of these study areas have been described by Carolin and Wright (4).

The sampling procedures and study methods used in 1951 and described by Carolin and Wright were largely duplicated in 1952. Population data were collected and degrees of parasitism were determined for four life stages of the budworm; the egg, immature larvae in buds, mature larvae, and pupae. Due to the limitations of time and personnel no investigations were made on the larvae of the needle mining stage, and no studies were made of the status of the budworm and its natural control on other unsprayed infestations outside the three intensive study areas already mentioned.

Status of Budworm Populations

Data were collected to obtain estimates of the 1953 population on all three study areas. These estimates are based on the average number of budworm found on representative foliage samples from representative trees within the infestations. Population counts were made for two stages of development, the immature larvae attacking the opened buds and the egg. Whole branches and 15-inch twigs were used as sampling units in the immature larval survey, and whole branches were sampled for the egg survey. The sampling procedures initiated in 1951 were carefully repeated at the same collection points in 1952, forming a basis for comparing the intensity of the infestation at each plot during the two year period. The population data obtained in 1951 and 1952 on the three unsprayed areas are summarized in Table 1.

At Chesnimnus the immature larvae survey showed a population increase of 60 percent, and aerial observation on the region-wide reconnaissance survey recorded an increase in the intensity of damage from light in 1951 to moderate in 1952. The subsequent egg mass survey showed an increase of 229 percent over 1951. On the basis of these data the 1953 infestation at Chesnimnus probably will be very heavy. However, studies in this area since 1949 have shown population fluctuations from season to season as a result of unknown natural control factors. Until the unknown factors have been assessed and added to the overall picture of the total natural control on the Chesnimnus infestation, no reliable prediction of the trend of the population is possible.

The low population density recorded at North Powder in 1951 continued in 1952, and no change in intensity of defoliation was noted on the aerial survey. An increase in the immature larval population was found, but this cannot be considered a significant trend of the population because of the very low general population. Furthermore a substantial decrease in the egg mass count was recorded. All of this indicates that a light population can be expected again in 1953.

The moderate infestation of 1951 on the Waterman Flat area continued at about the same level in 1952. This information is based on the immature larvae survey of 1952 which showed a slight decrease in population. No other population data were obtained at Waterman Flat as that infestation was sprayed for control at mid-season.

Status of Parasites

Parasitism was determined for four life stages of the budworm on the Chesnimnus and North Powder study areas. These stages were the egg, immature larvae (larvae attacking the newly opened vegetative buds), mature larvae, and pupae. The percentage of parasitism by parasite species for each of these stages, and the aggregate parasitism of all stages for 1950-1952 are summarized in Table 2.

Parasites of Eggs. In 1951, the degree of egg parasitism for the brood overwintering to 1952 was determined on all three study plots. Parasitism of this stage was found to be light or negligible on all plots. The common egg parasite, Trichogramma, was the only parasite observed in this phase of the study.

In 1952, the degree of egg parasitism for the new brood overwintering to 1953 was determined on the Chesnimnus and North Powder study areas. At Chesnimnus egg mortality was common with 22 egg masses out of 270 being parasitized. From the light infestation at North Powder only two egg masses were found, neither of which were parasitized. While no egg parasites were actually reared, the black color of the attacked eggs indicated that all egg parasitism on the Chesnimnus area was probably due to Trichogramma minutum Riley.

Parasites of Immature Larvae. Parasitism of young larvae attacking the newly-opened vegetative buds was considerable, averaging 30 percent for the three study areas. This represents a 32 percent increase in parasitism over that recorded in 1951. The trend toward heavier parasitism is attributed to increases in both major species of parasites attacking the immature larvae, Apanteles fumiferanae Vier. and Glypta fumiferanae (Vier). The third species of parasite commonly found attacking immature larvae, Campoplex sp., was only recovered in small numbers from the Chesnimnus and North Powder areas.

Parasites of Mature Larvae. The average combined parasitism of mature larvae on the Chesnimnus and North Powder study areas in 1952 remained slight; 7 percent in 1952 as compared with 8 percent in 1951. These are low orders of parasitism which obviously are not contributing greatly toward the natural control of the budworm on the study areas.

Omotoma fumiferanae (Tot.) Continued to be the most important parasite of mature larvae, parasitizing at Chesnimnus 8 percent of the larvae in 1952 and 6 percent in 1951, and at North Powder 4 percent of the larvae in 1952 and 7 percent in 1951. It is interesting to note that this parasite was recorded by Carolin (3) as causing over 16 percent parasitism in 1950 on areas of moderate to heavy infestation in the Blue Mountains. This indicates that Omotoma maybe more effective in heavier budworm populations.

Other parasites of the mature larvae were recovered in 1952, Madreymia saundersii (Will.) at Chesnimnus, and Phryxe pecosensis T.T. at North Powder. Both of these species of parasites appear to be relatively unimportant in these two study areas.

Parasites of Pupae. As in 1951 pupal parasitism in 1952 was low on the two study areas. The average combined parasitism for 1952 was 10 percent while the combined parasitism for 1951 was 4 percent. The increased parasitism in 1952 was due almost entirely to the increased abundance of Phaeogenes hariolus (Cress.). This species increased from 1 percent parasitism in 1951 to 8 percent in 1952 on the Chesnimnus area, and from none in 1951 to 4 percent in 1952 at North Powder. Phaeogenes, with the less important Itoplectis obesus (Cush.), and an unidentified species of hymenopteron (one specimen) were the only pupal parasites recovered in 1952 from the Chesnimnus and North Powder study areas.

Aggregrate Parasitism. Aggregate parasitism on the study plots in 1952 was light indicating that no significant decrease in population can be expected in 1953 from this factor of natural control. The aggregate parasitism in 1951 and 1952 on the three study areas is included in Table 2. This table shows there were no significant changes in aggregate parasitism from 1951 to 1952 on any of the study areas.

Natural Control Factors other than Parasites

The aggregate parasitism recorded on the North Powder and Waterman Flat study areas in 1951 was 37 percent and 24 percent respectively, yet population surveys in 1952 showed only a slight increase at North Powder and actually a decrease in population at Waterman Flat. Since it is assumed that at least 98.5 percent aggregate mortality is required to hold a budworm population static in the Northwest, some factors other than parasitism must have killed at least 97 percent of the population unaffected by parasites.

Unseasonable weather conditions, disease, attacks by birds, predacious insects, spiders, mites, etc. are all recognized factors of natural control operating to hold budworm populations in check. Mortality due to unusually cold weather has been observed in populations of young larvae migrating from mined needles to vegetative buds on one infestation in eastern Oregon near La Grande. W. J. Buckhorn, who observed the mortality in early June 1951, estimated the decrease at 25 percent of the population present. V. M. Carolin reported in 1950 (3) that in the short interval of one week only one-third of an original needle mining larval population could be accounted for on a study plot in eastern Oregon. Intensive mortality studies by Jaynes and Speers (7) and Dowden and Carolin (5) in the Northeast have shown that high mortalities consistently occur between the time when eggs hatch late in the summer and when the tiny larvae start feeding in the newly opened vegetative buds the following spring. In their studies they recorded mortalities during this period of development as high as 74 to 86 percent.

Observations on the three areas under intensive study in 1951 and 1952 failed to indicate which one or combination of natural control factors were responsible for the high aggregate mortality we now know existed in addition to parasitism. Disease and birds, which have frequently been considered as important factors of natural control, were not observed to be causing abnormal mortality in 1951 or 1952. On the basis of the meager information available it appears that overwintering mortality factors exerted considerable natural control on the study areas, particularly on the light and moderate infestations at North Powder and Waterman Flat.

STUDIES IN 1952 ON SPRAYED AREAS

The study plots established in 1951 on eight sprayed areas in Oregon and Washington were resurveyed in 1952 to record the status of the budworm and its parasites. The study areas and sampling methods used in 1951 have been described by Carolin and Wright (4). Their methods of sampling immature larvae were duplicated in 1952, but the sampling of mature larvae was omitted due to time and personnel limitations. Budworm population data were recorded primarily to determine the status of the residual population on sprayed areas two and three years after treatment. All immature larvae collected on the population survey were preserved and later dissected for degree of parasitism. These degrees of parasitism in immature larvae show the effectiveness of parasitism in the natural control of low level populations, and also are a measure of the parasite population which survived the spray treatment.

Status of Budworm Populations

Population data were based on the average number of immature larvae attacking 15-inch twigs. The estimates of population from these sample data collected in 1951 and 1952 are summarized in Table 3 for each of the eight sprayed areas.

On the Mt. Hood sprayed area one study plot, Beaver Butte, was found to have an epidemic population of moderate intensity in 1952. Two other sprayed areas, Catherine Creek and Walla Walla showed significant populations; and one area McKenzie, showed a substantial increase although the population was still very low. Larvae were found at all of the remaining areas; Roseburg, Eugene, South Umatilla and Tollgate, but in such small numbers that the budworm appears to have been nearly eradicated on those areas.

The infestation at Mt. Hood has been under close observation since it was sprayed in 1949 because it was suspected that poor control might have been obtained due to the rather high percentage of pupation at the time of spraying. The entire infestation in that area, including two of the three study plots, three were resprayed in 1952 as a part of the Bureau's height of flight experiment (1). The study area at McKenzie was also resprayed, the one study plot there being included in the buffer strip around the control unit sprayed in 1952.

The relatively high endemic populations found in 1952 at Catherine Creek and Walla Walla and the increasing, although low, population at McKenzie may reflect only insignificant seasonal fluctuations, however, the possibility also remains that these conditions may mark the very early beginning of trends toward higher populations on areas sprayed several years ago. The populations on these areas during the next few years are expected to show the significance of fluctuations in relatively low populations.

Status of Parasites

Parasitism of the immature larvae attacking vegetative buds was determined on the sprayed areas in 1952. On some individual areas, particularly on the western or Cascade sprayed areas at Eugene and McKenzie, the population sampled for parasitism was inadequate to obtain a reliable measure of the degree of parasitism. For all areas parasitism was 32 percent, averaging 31 percent for the four western areas and 35 percent for the four eastern areas. The abundance of the three species of parasites attacking immature larvae was variable from area to area, but Glypta fumiferanae(Vier.) was most common, Apanteles fumiferanae Vier. next most common, with Campoplex sp. the least common. There was no significant difference in the abundance of these parasites between western and eastern sprayed areas. The percent parasitism found on each of the eight sprayed areas is summarized for 1951 and 1952 in Table 4. It is interesting to note that in 1952 the average total parasitism of the immature larvae on the sprayed areas is greater than the comparable parasitism on the unsprayed areas.

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APPENDIX

In this report references have been made to the biological data collected in 1951 and 1952. These data have been summarized in Tables 1 to 4. Basic data used in compiling these tables and not set down elsewhere is tabulated in Tables 5 and 6. The tabulations show budworm populations and parasitism by study plots for the eight sprayed areas. The trends on the individual plots in sprayed areas are not yet significant due to the short period over which the data has been collected, but these data may be of considerable interest in future years due to variations of infestations within the sprayed areas.

TABLE 1. ESTIMATES OF SPRUCE BUDWORM POPULATIONS ON THREE UNSPRAYED STUDY AREAS IN EASTERN OREGON, 1951 - 1952

YEAR	STUDY AREA	DEFOLIATION*	IMMATURE LARVAE POPULATION			EGG MASSES		
			Number of Samples	Number of Larvae Collected	Larvae Per Sampling Unit	Number of Samples	Number of Egg Masses Collected	Egg Masses Per Sampling Unit
1951								
	Chesnimnus	Light	21 Branches	790	37.6	20 Branches	81	4.1
	North Powder	Light	150 15-in.twigs	112	0.7	20 Branches	18	0.9
	Waterman Flat	Moderate	100 15-in.twigs	367	3.7	20 Branches	64	3.2
1952								
	Chesnimnus	Moderate	12 Branches	724	60.3	20 Branches	270	13.5
	North Powder	Light	100 15-in.twigs	143	1.4	20 Branches	2	0.1
	Waterman Flat	(Sprayed)	100 15-in.twigs	255	2.5	--	--	--

* Defoliation is based on aerial reconnaissance survey observations where "light" is defoliation barely visible from the air, "moderate" is top one-fourth of the visible crown defoliated; "heavy" is the top one-half of visible crown defoliated; and "very heavy" is the visible crown completely defoliated.

TABLE 2. PERCENT PARASITISM OF THE SPRUCE BUDWORM ON THREE UNSPRAYED AREAS IN OREGON AND WASHINGTON 1951-1952

STAGE OF HOST KILLED AND PARASITE SPECIES	CHESNIMNUS				NORTH POWDER				WATERMAN FLAT			
	1951		1952		1951		1952		1951		1952	
	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %
EGG*	81		270		18		2		64		-	
Trichogramma minutum		5.0		8.1		0.0		0.0		0.0		-
IMMATURE LARVAE	300		-		112		-		367		-	
Unknown		0.7		-		4.5		-		0.0		-
IMMATURE LARVAE	233		100		173		84		174		100	
Apanteles-fumiferanae		9.4		10.0		11.6		13.1		12.1		18.0
Glypta fumiferanae		13.7		19.0		3.7		7.1		5.1		20.0
Campoplex species		2.6		1.0		3.5		1.2		1.2		0.0
Combined parasitism		25.8		30.0		23.7		21.4		18.4		38.0
MATURE LARVAE	250		188		102		186		250		**	
Cnotoma fumiferanae		6.0		8.0		6.9		3.8		0.0		
Ceromasia auricaudata		0.0		0.0		2.0		0.0		0.4		
Phytodietus fumiferanae		1.2		0.0		1.0		0.0		2.8		

Continued

TABLE 2. PERCENT PARASITISM OF THE SPRUCE BUDWORM ON THREE UNSPRAYED AREAS IN OREGON AND WASHINGTON 1951-1952

STAGE OF HOST KILLED AND PARASITE SPECIES	CHESNIMNUS				NORTH POWDER				WATERMAN FLAT			
	1951		1952		1951		1952		1951		1952	
	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %	No. SBW Sampled	Parasitism %
Madremyia saundersii		0.0		0.5		0.0		0.0		2.0		
Phryxe pecosensis		0.0		0.0		0.0		0.5		0.0		
Unknown species		0.4		0.0		0.0		0.5		0.0		
Combined parasitism		7.6		8.5		9.8		4.8		5.2		
PUPAE	229		366		261		127		209			
Itoplectis obesus		0.9		0.8		1.9		3.1		1.5		
Phaeogenes hariolus		1.3		7.9		0.0		3.9		0.0		
Ephialtes ontario		0.9		0.0		0.0		0.0		0.0		
Agria affinis		1.7		0.0		0.0		0.0		0.0		
Brachymeria species		0.0		0.0		0.4		0.0		0.0		
Unknown species		2.2		2.5		0.0		0.8		0.0		
Combined parasitism		7.0		11.2		2.3		7.9		1.5		
AGGREGATE PARASITISM		38.6		46.0		37.0		31.1		24.3		

* Egg samples refers to the number of egg masses examined and percent of masses parasitized.
** Study plot sprayed for control in June 1952.

TABLE 3. ESTIMATES OF SPRUCE BUDWORM POPULATIONS ON EIGHT SPRAYED AREAS IN OREGON AND WASHINGTON

LOCATION AND STUDY AREA	YEAR SPRAYED	Larval Populations* (Based on 15-inch twig samples)			
		BEFORE SPRAYING	AFTER SPRAYING	1951	1952
CASCADES					
Roseburg	1950	8.4	0.1	Nil **	Nil
Eugene	1949	13.5	0.3	Nil	Nil
McKenzie	1950	4.8	0.1	Nil	0.1
Mt. Hood	1949	10.3	0.2	0.5	1.8
BLUE MOUNTAINS					
So. Umatilla	1950	6.7	Nil	Nil	Nil
Catherine Cr.	1950	8.7	Nil	0.2	0.2
Walla Walla	1950	5.0	0.1	0.1	0.3
Tollgate	1950	6.9	0.1	0.1	Nil

* Larval populations for before spraying are based on samples of predominantly 5th instar larvae, for after spraying on 6th instar larvae and pupae, and for the 1951 and 1952 populations on 3rd and 4th instar larvae.

** Nil - Indicates a population of less than 0.05 larvae per 15-inch twig.

TABLE 4. PARASITISM OF IMMATURE SPRUCE BUDWORM LARVAE ON EIGHT SPRAYED AREAS IN OREGON AND WASHINGTON, 1951-1952

LOCATION AND STUDY AREA	1951		1952	
	NUMBER OF SPRUCE BUDWORM SAMPLED	TOTAL PARASITISM %	NUMBER OF SPRUCE BUDWORM SAMPLED	TOTAL PARASITISM %
CASCADES				
Roseburg	24	38	1	0
Eugene	8	25	7	14
McKenzie	7	29	7	14
Mt. Hood	175	33	152	32
BLUE MTS.				
So.Umatilla	44	59	1	100
Catherine Cr.	137	41	53	34
Walla Walla	37	51	3	67
Tollgate	15	67	27	30

TABLE 5. TABULATION OF SPRUCE BUDWORM POPULATION FROM IMMATURE LARVAL SURVEY OF EIGHT SPRAYED AREAS IN OREGON AND WASHINGTON, 1951-1952.

AREA AND LOCALITY	YEAR SPRAYED	1951 POPULATION: No. 15" Twigs Sampled	1951 POPULATION: No. of Spruce Budworm	1951 POPULATION: No. Spruce Budworm Per Twig	1952 POPULATION: No. 15" Twigs Sampled	1952 POPULATION: No. of Spruce Budworm	1952 POPULATION: No. Spruce Budworm Per Twig
Roseburg							
Henry Mill	1950	300	18	.06	100	0	.00
S&S Mill	1950	300	5	.02	90	1	.01
Clover Creek	1950	150	1	.01	50	0	.00
Eugene							
Creswell	1949	300	1	.00	100	2	.02
Sodaville	1949	300	1	.00	100	1	.01
Seavay Ranch	1949	300	1	.00	100	2	.02
Kampfer "	1949	300	1	.00	100	2	.02
Oakridge	1949	300	3	.01	100	0	.00
McKenzie							
Frissel Cross	1950	300	7	.02	100	8	.08
Mt. Hood							
Wamic	1949	300	1	.00	100	2	.02
Bear Springs	1949	300	74	.25	100	54	.54
Beaver Butte	1949	150	385	2.57	55	402	7.31
South Umatilla							
Nigger Nob	1950	300	8	.03	100	1	.01
Madison Butte	1950	300	18	.06	100	0	.00
Red Hill L.O.	1950	300	18	.06	100	0	.00
Catherine Creek							
Bald Mt.Rd.	1950	300	45	.15	100	19	.19
Lt.Catherine Creek	1950	300	16	.05	100	4	.04
Reeve's Mt.	1950	300	76	.25	100	31	.31
Walla Walla							
Baby Springs	1950	300	37	.12	85	28	.33
Tollgate							
Langdon Lake	1950	300	15	.05	100	4	.04

TABLE 6. TABULATION OF THE SPRUCE BUDWORM PARASITISM DURING THE IMMATURE LARVAL STAGE ON EIGHT SPRAYED AREAS IN OREGON AND WASHINGTON, 1952

AREA AND STUDY PLOT	YEAR SPRAYED	NO. SPRUCE BUDWORM SAMPLED	PARASITE SPECIES: APANTELES No.	APANTELES %	GLYPTA No.	GLYPTA %	CAMPOPLEX No.	CAMPOPLEX %	OTHER SPP. No.	OTHER SPP. %	TOTAL PARASITISM No.	TOTAL PARASITISM %
ROSEBURG	1950											
Henry Mill		0										
S&S Mill		1										
Clover Creek		0										
Subtotal		1										
EUGENE	1950											
Creswell		2										
Sodaville		1										
Seavey Ranch		2										
Kampfer Ranch		2	1	50.0							1	50.0
Oakridge		0										
Subtotal		7	1	14.3							1	14.3
MC KENZIE	1950											
Frissel Crossing		7			1	14.3					1	14.3
Subtotal		7			1	14.3					1	14.3
MT. HOOD	1949											
Wamic		2										
Bear Springs		54	4	7.4	9	16.7	1	1.9	5	9.2	19	35.2
Beaver Butte		96	11	11.4	14	14.6			5	5.2	30	31.2
Subtotal		152	15	9.9	23	15.1	1	0.7	10	6.6	49	32.3
SO. UMATILLA	1950											
Nigger Nob		1			1	100.0					1	100.0
Madison Butte		0										
Red Hill L.O.		0										
Subtotal		1			1	100.0					1	100.0

TABLE 6. TABULATION OF THE SPRUCE BUDWORM PARASITISM DURING THE IMMATURE LARVAL STAGE ON
Continued EIGHT SPRAYED AREAS IN OREGON AND WASHINGTON, 1952

AREA AND STUDY PLOT	YEAR SPRAYED	NO. SPRUCE BUDWORM SAMPLED	PARASITE SPECIES: APANTELES No.	APANTELES %	GLYPTA No.	GLYPTA %	CAMPOPLEX No.	CAMPOPLEX %	OTHER SPP. No.	OTHER SPP. %	TOTAL PARASITISM No.	TOTAL PARASITISM %
CATHERINE CREEK	1950											
Bald Mt. Road		19	1	5.3	3	15.7	1	5.3	1	5.3	6	31.6
Little Catherine		4			1	25.0					1	25.0
Reeves Mt.		30	6	20.0	3	10.0	2	6.7			11	36.7
Subtotal		53	7	13.2	7	13.2	3	5.7	1	1.9	18	34.0
WALLA WALLA	1950											
Baby Springs		27	2	7.4	5	18.5			1	3.7	8	29.6
Subtotal		27	2	7.4	5	18.5			1	3.7	8	29.6
TOLLGATE	1950											
Langdon Lake		3	1	33.3	1	33.3					2	66.7
Subtotal		3	1	33.3	1	33.3					2	66.7